Proposed Agreement between California Energy Commission and The Regents of the University of California, Riverside

Title: Production of Substituted Natural Gas from the Wet Organic Waste by utilizing PDU-scale Steam Hydrogasification Process
Amount: $649,214.00
Term: 13 months
Contact: David Effross
Committee Meeting: 7/20/2011

Funding

FY	Program	Area	Initiative	Budget	This Project	Remaining Balance	
10	Natural Gas	Transportation	Research, Develop, and Deploy Alternative Fuels that Reduce Petroleum Consumption and Transportation	$3,250,000	$649,214	$2,600,536	80%

Recommendation

Approve this agreement with UC Riverside for $649,214.00. Staff recommends placing this item on the discussion agenda of the Energy Commission Business Meeting on 8/24.

Issue

California must produce nearly 2.4 billion gasoline gallon equivalents per year of alternative transportation fuels in order to meet the petroleum reduction objectives of the State Alternative Fuels Plan 2017. Current annual usage of ethanol is approximately 1 billion gallons, with another 4 million gallons of biodiesel produced (California Biomass Collaborative 2006). Currently, California imports more than 95 percent of the biofuels used in-state. Ramping up in-state biofuel production without competing with existing cropland will be difficult unless other non-crop biomass resources can be used.

A recent California biomass availability assessment found that California generates approximately 83 million dry tons of biomass wastes per year creating various unresolved waste disposal issues for agricultural and forestry biomass residue streams as well as large volumes of biosolids resulting from wastewater treatment facilities. Studies show that 32.1 million dry tons of biomass from agricultural residues is available every year for fuel production when sustainability and harvesting efficiency factors are considered. Further research and development is required to establish commercially-viable waste-to-energy conversion technologies that can simultaneously contribute supplies of renewable transportation fuels and transform waste materials into renewable transportation fuels.

Wet organic waste such as biosolids, food wastes and green/ vegetation waste are important sources of renewable carbon that are under- utilized in the production of biofuels. Currently, most of these wastes are landfilled. The fraction of these wastes generated in California has increase from 23% (2004) to 26% (2008) and is expected to increase more so in the future. These types of wastes tend to have more environmental issues associated with proper disposal compared to other type of the waste. Typically, these feedstocks do not lend themselves as feedstock for large capacity commercial facilities because the feedstock amounts needed are seldom available within a reasonable transportation distance. Hence, technologies used to process these feeds must be commercially viable in smaller scales and also be able to accommodate the diverse nature of local feedstocks including ones with high moisture content.

The increasing price of natural gas along with a decreasing supply in California presents a critical need to develop low-cost replacements for natural gas. Thermo-chemical production of Substituted Natural Gas (SNG) from renewable sources offers a viable solution for the concerns of natural gas supply. Unfortunately, conventional processes for SNG production such as anaerobic-digestion and gasification or methanation of partial oxidation product gas have several limitations.

The potential SNG produced using the proposed process is about 83,000 million cubic feet, which accounts for 7.2% of total natural gas consumed in California in 2009.

UCR/CE-CERT's research has been funded by PIER Transportation so far, and is a star among PIER's projects. It has achieved significant results so far, including coming very close to producing renewable gasoline, a much more difficult challenge than renewable diesel fuel. Funding this Interagency Agreement would enable continuation of UCR/CE_CERT's steam hydrogasification research to full fruition.

Background

This work follows on a successful interagency agreement with UCR/CE-CERT, 500-09-008, Hydrogasification Research and Demonstration, which ended in August 2011. It intends to continue that research. A PDU scale bubbling fluidized bed SHR, which was developed with previous PIER program support, will be extended to produce the SNG.

Proposed Work

This agreement will co-fund the further development of a promising new waste-to-energy technology known as the Steam Hydrogasification Reaction (SHR) process, which has been demonstrated successfully for the production of clean syngas at the Process Demonstration Unit (PDU) scale by the University of California (UC), Riverside, College of Engineering, Center for Environmental Research and Technology (CE-CERT) within the PIER program from CEC.

A PDU (process demonstration unit) scale bubbling fluidized bed SHR, which was developed with previous PIER program support, will be extended to produce the SNG. This task will include: (1) the design, construction and integration of the WGS with the capacity enough to handle the producer gas of the SHR, and (2) modification of the feedstock input system to increase the range of feedstock from biosolid to other type of wet feedstock such as food wastes and green waste

The research will be primarily conducted at the gasification research laboratory at the University of California, Riverside College of Engineering, Center for Environmental Research and Technology (CE-

CERT) in Riverside California with assistance from the industrial partner, Food Recycling Service, and the City of Riverside Waste Water Treatment Facility. The program will be managed by the Principal Investigator Prof. Joseph Norbeck and Dr. Chan Park. The program objectives and individuals responsible for the objectives are contained in the Statement of Work. Drs. Norbeck and Park have considerable research experience and knowledge in the gasification process. The technical tasks will be performed by research engineers, post-doctoral research and PhD graduate students within the CE-CERT organization and FRS.

This work will take roughly one year to complete. Steam hydrogasification is a new, breakthrough technology that will be demonstrated beyond the bench scale for the first time. This project will obtain critical information necessary to develop a pilot scale and then commercial scale facility. This technology has the potential to be a significantly important for conversion of problematic waste streams to valued products in a cost efficient manner. There are several difficult engineering and process modeling tasks in this phase that will take considerable engineering expertise to accomplish and are not possible to do in parallel. Every effort will be taken to reduce the time beyond the expected 1 year time frame.

The agreement cost structure in a nutshell:

- Direct Labor accounts for $282,158, or 43% of total PIER Reimbursable costs.
- Fringe Benefits accounts for $62,947, or 10% of total PIER Reimbursable costs.
- Materials accounts for $21,700, or 3% of total PIER Reimbursable costs.
- Equipment accounts for $110,000, or 17% of total PIER Reimbursable costs.
- Travel accounts for $500, or 0% of total PIER Reimbursable costs.
- Miscellaneous accounts for $87,661, or 14% of total PIER Reimbursable costs.
- Minor Subcontractors account for $0, or 0% of total PIER Reimbursable costs.
- Major Subcontractors account for $0 , or 0% of total PIER Reimbursable costs.
- Indirect Overhead accounts for $84,245, or 13% of total PIER Reimbursable costs.
- G&A accounts for $0, or 0% of total PIER Reimbursable costs.
- Profit accounts for $0, or 0% of total PIER Reimbursable costs.

Total PIER Reimbursable Cost is $649,211. $200,000 is being supplied in match by Food Recycle Science, Inc. (FRS). FRS is a California based venture company that has developed an innovative processing technology for food waste called eCorect, designed to process food wastes or organic waste at food-serving and food-handling facilities. FRS's proprietary hydro-thermolytic process dehydrates, sterilizes and converts organic waste into Highly Concentrated Organic (HCO) biomass particulate within several hours. The end product has uniform chemical and physical properties, which appears to perfectly meet the feedstock requirements of the CE-CERT process. The eCorect process concept and its thermo-mechanical designs are currently protected by 4 U.S. Patent Applications.

If this project is successful this project will be significant impact on the State of California and the nation of meeting goals contained in low carbon fuel standards, clean sustainable transportation fuels and reducing land fill of problematic waste streams. There are several agencies who have interest in the results of this project including the California Air Resources Board, the USEPA, the Integrated Waste Management Board, waste water treatment facilities, and local air pollution agencies.

The most important results will be engineering design information that will lead to the development of both a pilot scale facility and a commercial facility. This information will be documented in CEC reports, professional and technical meetings and peer reviewed publications.

The results will be used by the industrial partners and the CEC to determine the overall feasibility and cost effectiveness to move forward with commercial facilities. The information obtained in this project will be critical to efforts to commercialize this promising technology.

There are 11 patents awarded or pending. It is possible that new intellectual property will be developed from this project. When appropriate new potential invention disclosures will be explored.

Justification and Goals

This project "[will develop, and help bring to market] advanced transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefit electricity and natural gas ratepayers" (Public Resources Code 25620.1.(b)(1)), (Chapter 512, Statues of 2006)).

This project also addresses GHG reduction and natural gas cost. A conservative estimate follows.

13.71 MMBtu are produced per ton of feedstock. Based upon 2008 data, total wet waste in California was 9,820,0000 tons. This could produce 132,034 MMCF of SNG, for a 5.5% replacement of natural gas produced in California and a 3.8 Mton GHG reduction. SNG costs 55% of NG, so this would result in a cost saving of $606 million based upon displaced NG.

This will be accomplished by:

- Validate the performance and product quality of the feed pretreatment process of the PDU under the optimum conditions.
- Validate the production and quality of SNG from the SHR-WGS integrated process of the PDU under the optimum operating conditions.
- Develop the basic engineering design of the 5 tons per day pilot plant to be sited at the wastewater treatment facility in Riverside, CA or at another city site if determined later during the project phase of the program.
- Complete the feasibility study of algae feedstock for SHR process. The feasibility study shall contain the following deliverables.
- Complete the feasibility study of new zeolite encapsulated FT catalyst for synthetic gasoline production.